(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 705 990 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
10.04.1996 Bulletin 1996/15

(51) Int Cl.^{6}: F16C 11/06

(21) Application number: 95306972.1

(22) Date of filing: 02.10.1995

(84) Designated Contracting States:
DE FR GB

(30) Priority: 30.09.1994 JP 236236/94
04.04.1995 JP 79172/95

(71) Applicant: THK CO. LTD.
Tokyo 141 (JP)

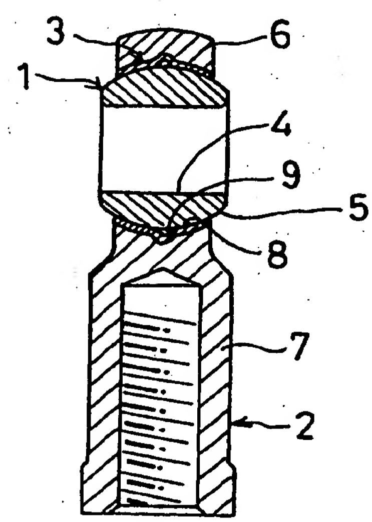
(72) Inventors:
- Teramachi, Hiroshi, c/o THK Co., Ltd. Tokyo (JP)
- Shirai, Takeki, c/o THK Co., Ltd. Tokyo (JP)
- Murata, Shigeru, c/o THK Co., Ltd. Tokyo (JP)

(74) Representative: Hague, Alison Jane
Frank B. Dehn & Co.
Imperial House
15-19 Kingsway
London WC2B 6UZ (GB)

(54) Spherical joint and process for manufacturing the same

(57) The present invention relates to a spherical joint for transmitting rotating and rocking motions between an inner member (1; 21) and an outer member (2; 24) in sliding contact with each other, and provides a spherical joint which is excellent in the mechanical strength and capable of achieving smooth rocking or rotating motions, and a process for manufacturing the spherical joint. In order to achieve this object, according to the present invention, there is provided a spherical joint comprising: an inner member (1; 21) having a convex-spherical surface (5); an outer member (2; 24) cast by using the inner member (1; 21) as a core and so connected to the inner member (1; 21) as to rock and rotate relative to the inner member (1; 21); and a bushing (3; 27) sandwiched between the inner member (1; 21) and the outer member (2;24) and having a concave-spherical surface (8) for sliding contact with the convex-spherical surface (5) of the inner member (1; 21). When the outer member (2; 24) is to be cast, the bushing (3; 27) made of a thin metal is partially fused to and rigidly unified with the cast outer member (2; 24).

FIG. 2



EP 0 705 990 A2

Description

The present invention relates to a spherical Joint and a process for manufacturing the same. More particularly, the present invention relates to a spherical Joint, which can establish smooth rotating and rocking motions and finds its suitable application to a transmission or a steering unit of an automobile or a link motion mechanism of other various automatic machines, and a process for manufacturing the same.

In the prior art, the spherical joint of this kind is constructed, as shown in Figs. 18 and 19, to include an inner member 101 having a ball portion 100 at its one end, and an outer member 103 having a ball retaining portion for retaining the ball portion 100 and engaging generally in the shape of letter "L" with the inner member 101. In this known spherical Joint, the inner member 101 and the outer member 103 are so connected to each other as to rock or rotate (as disclosed in Japanese Patent Publication No. 77886/1993).

In order to realize the smooth rocking or rotating motions of the inner member 101, the spherical Joint, as disclosed, is manufactured as follows. First of all, the outer member 103 having the ball portion 100 retained in the ball retaining portion 102 is cast by exemplifying a core by the ball to form the ball portion 100 of the inner member 101. Next, a threaded portion 104 is welded to the ball which is exposed from the ball retaining portion 102, to form the inner member 101. After this, an external force is finally applied to the ball retaining portion 102 of the outer member 103 to form a clearance between the ball portion 100 of the inner member 101 and the ball retaining portion 102 of the outer member 103. According to this manufacture method, the ball such as a bearing steel ball having a high sphericalness is used as the core at the casting time. As a result, the spherical surface of the ball is transferred at the casting time to the ball retaining portion 102 of the outer member 103 so that the clearance between the ball portion 100 of the inner member 101 and the ball retaining portion 102 of the outer member 103 can be minimized. This makes it possible to achieve the light and smooth rocking or rotating motions of the inner member 101.

In this spherical Joint, on the other hand, the inner member and the outer member are in direct sliding contact. Hence, the material for making the outer member has to be excellent not only in mechanical strength but also in characteristics as the bearing. However, materials capable of satisfying these two characteristics are limited, raising a problem that it is difficult to achieve lower costs by mass production

Therefore, there have been proposed spherical joints in which a bearing material is sandwiched between the outer member and the inner member.

In one proposed spherical joint, as disclosed in Japanese Patent Laid-Open No. 12118/1989, there is sandwiched between an inner ring or the inner member and the outer member a bearing sheet of a resin, in which is buried a metallic mesh member to function as the bearing for the convex-spherical surface of the inner ring.

This spherical joint is manufactured by a process substantially identical to that of the spherical Joint of Japanese Patent Publication No. 66886/1993, but the bearing sheet is covered in advance with the inner ring when the outer member is to be cast by using the inner ring as the core. As a result, when the outer member is cast by pouring the molten metal into the mold, the inner circumference of the outer member partially bites into the mesh member of the bearing sheet so that the bearing sheet and the outer member can be rigidly unified.

In this spherical joint, however, the bearing sheet is exemplified by one made of a resin. As a result, the bearing sheet will melt at its portion contacting with the molten metal, when the outer member is to be cast, to raise a problem that a gall is formed between the exposed metallic mesh member and the inner ring.

When the outer member is to be cast, moreover, the end portion of the bearing sheet and the sprue cutting portion of the casting mold have to come into contact so that the molten metal poured into the mold may be prevented from flowing out toward the inner member. The sprue cutting portion of the mold is difficult to bring into rigid contact with the bearing sheet of a resin. As a result, the molten metal may flow out of the gap between the bearing sheet and the sprue cutting portion toward the inner ring thereby to fix the inner ring and the outer member. Moreover, the end portion of the bearing sheet may contact and melt with the molten metal to establish a clearance between the bearing sheet and the sprue cutting portion.

Another spherical joint is known, as disclosed in Japanese Patent Publication No. 12655/1978. In this spherical joint, a bearing metal layer having a lower melting point is cast on the surface of a ball, and an outer member having a higher melting point is then cast by using the ball as the core. Thus, when the outer member is cast, the bearing metal layer once contacts and melts with the molten metal so that the bearing metal layer and the outer member are rigidly unified after cooling down. If an external force is applied in this state to the aforementioned ball, a fine clearance is established between the bearing metal layer and the ball to allow smooth rocking or rotating motions of the rod which is welded to the ball.

According to this manufacture process, however, the end portion of the cast bearing metal layer is liable to have burrs, which will form a clearance between the end portion of the bearing metal layer and the sprue cutting portion of the mold. As a result, the molten metal may flow out of the clearance between the bearing metal layer and the sprue cutting portion toward the inner ring thereby to fix the inner ring and the outer member.

According to this manufacture process, moreover, a small difference in the melting point prevails between the bearing metal layer and the outer member. If the molten metal contacts with the bearing metal layer when the out-

er member is to be cast, the bearing metal layer is partially melted again. As a result, the metallic materials of the bearing metal layer and the outer member partially mix into each other so that the bearing metal layer loses its initial metallic characteristics. Thus, there arise problems that the bearing metal layer has its durability lowered against the load and that a seizure between the ball and the bearing metal layer is liable to occur due to the frictional heat.

Incidentally, the spherical joint thus constructed is used in a link mechanism, as shown in Fig. 20, which is constructed by connecting the outer members 103 and 103 of a pair of spherical Joints J through a connecting rod 105 and by fixing the individual inner members 101 and 101 on the different moving parts (although not shown) to transmit the load from one moving part to the other. As a result, in each spherical Joint, the load acts mainly in a direction perpendicular to the inner member 101.

Because of the clearance of the spherical joint between the ball portion of the inner member and the ball retaining portion of the outer member, however, backlashes, as indicated by arrows A, B and C in Figs. 18 and 19, are caused between the inner member and the outer member if the link mechanism is vibrated as a whole under the condition of no load transmission.

With these backlashes, the ball portion and the ball retaining portion repeat their collisions to enlarge the clearance between the ball portion and the ball retaining portion thereby to make it difficult to accurately transmit the motion of one moving portion to the other. As a result of this enlarged clearance, moreover, a vicious cycle arises to increase the backlashes drastically between the inner member and the outer member. Because of these backlashes, moreover, the spherical surface of the ball portion or the ball retaining portion is deformed to raise a problem that the rocking and rotating motions lose their smoothness as time elapses.

If, on the other hand, an impact load or an abrupt acceleration acts upon the line mechanism in its entirety under the condition of no load transmission, the outer member may fall in the direction, as indicated by arrow D in Fig. 19, relative to the inner member. This results in a problem that a collision noise is generated at each fall between the edge portion of the ball retaining portion of the outer member and the inner member.

Viewed from one aspect the present invention provides a spherical joint comprising: an inner member having a convex-spherical surface; an outer member cast by using the inner member as a core and so connected to the inner member as to be capable of rocking and rotating relative to the inner member; and a bushing sandwiched between the inner member and the outer member and having a concave-spherical surface for sliding contact with the convex-spherical surface of the inner member. When the outer member is cast, the bushing made of a thin metal is partially fused to and rigidly unified with the cast outer member.

In the present invention, the inner member having the convex-spherical surface may be a ball or an inner ring having the convex-spherical surface on its outer surface. Moreover, the inner member may be made of materials, which are used in spherical joints of this kind in the prior art, such as bearing steel (i.e., high-carbon bearing steel).

On the other hand, the outer member for holding the inner member is made of a metal suited for die-casting, such as aluminum or its alloys, zinc or its alloys. As to the melting point of this die-casting metal, moreover, a temperature of 570 to 750 °C is preferable for the aluminum metal, and a temperature of 420 to 450 °C is preferable for the zinc metal.

The thickness of the bushing to be sandwiched between the inner member and the outer member can be suitably designed. If the thickness is less than 0.3 mm, however, the forced contact between the bushing and the mold is so incomplete at the time of casting the outer member that the molten metal flows over the bushing and sticks to the inner member. If the thickness exceeds 0.8 mm, on the other hand, the bushing is difficult to bring into close contact with the convex-spherical surface of the inner member by a pressing operation. Hence, the preferable thickness of the bushing is 0.4 to 0.6 mm.

The aforementioned bushing has to be fused to the outer member at the time of casting the outer member, and the material for the bushing can be for example brass [YBsC1 - YBsC4 having a melting point (in solid phase) of 915 °C], lead brass [having a melting point (in solid phase) of 885 °C], free-cutting brass [C3560R having a melting point (in solid phase) of 885 °C], forging brass [having a melting point (in solid phase) of 880 °C], aluminum brass [having a melting point (in solid phase) of 935 °C], phosphor bronze [PBC2 to PBC3 having a melting point (in solid phase) of 880 to 950 °C], or aluminum bronze [AlBC1 to AlBC2 having a melting point (in solid phase) of 1,037 to 1,062 °C]. The preferable material is a copper metal having a melting point of 800 to 900 °C . In order to achieve the fusion to the outer member reliably and more rigidly, more preferably, the difference from the melting point of the metal of the outer member is within a range of 100 to 400 °C . Incidentally, the letters and numerals, as attached to the individual materials, are symbols according to Japanese Industrial Standards.

In case the lubrication between the bushing and the inner member is taken into consideration, on the other hand, the bushing is preferred to have an annular groove which is formed in the circumferential direction of its concave-spherical surface to act as a lubricating oil reservoir. With this annular groove, moreover, the fixture of the bushing to the outer member can be made stronger.

Viewed from another aspect the present invention provides a process for manufacturing a spherical joint, which spherical joint includes: an inner member having a convex-spherical surface; an outer member cast by using said inner member as a core and so connected to

said inner member as to be capable of rocking and rotating relative to said inner member; and a bushing sandwiched between said inner member and said outer member and having a concave-spherical surface for sliding contact with the convex-spherical surface of said inner member, the process comprising:

> the step of covering said inner member with said bushing, which bushing is made of a thin metal;
> the step of placing said inner member covered with said bushing in a casting mold and pouring a molten metal into said casting mold to cast said outer member and to fuse said bushing to said outer member;
> the step of extracting the outer member connected to said inner member, from said casting mold and cooling down said outer member, and fastening said bushing onto the convex-spherical surface of said inner member by using the shrinkage of said outer member, to bring the convex-spherical surface of said inner member and the concave-spherical surface of said bushing into close contact with each other; and
> the step of applying an external force to said inner member or said outer member to establish a fine clearance between the convex-spherical surface of said inner member and the concave-spherical surface of said bushing.

At least preferably said bushing is formed by pressing a hollow cylindrical sheet of metal around the inner member, said sheet being sufficiently thin to suitably form said bushing by a pressing technique.

In the spherical joint of this kind, on the other hand, the inner member is the more liable to establish the backlash with respect to the outer member under the condition of no load as the rocking or rotating motions of the inner member relative to the outer member are the smoother. In order to prevent these backlashes, therefore, the ball retaining portion of the outer member may be formed with a mouth communicating with the convex-spherical surface of the inner member, and an elastic member may be mounted in that mouth for thrusting against the inner member. With this construction, the backlash of the inner member relative to the outer member can preferably be eliminated even in the state where no load is transmitted between the inner member and the outer member.

Indeed, this aspect is considered advantageous in its own right and viewed from another aspect the present invention provides a spherical joint comprising: an inner member having a convex-spherical surface; and an outer member cast by using said inner member as a core and so connected to said inner member as to be capable of rocking and rotating relative to said inner member,

characterised by: a mouth formed in the ball retaining portion of said outer member and communicating with the convex-spherical surface of said inner member; and an elastic member fitted in said mouth for thrusting against said convex-spherical surface, when a load is not transmitted between said inner member and said outer member, and for being thrust and deformed by said convex-spherical surface when a load is transmitted between said inner member and said outer member.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, wherein:

> Fig. 1 is a front elevation showing a spherical joint according to Embodiment 1 of the present invention;
> Fig. 2 is a section taken along line II - II of Fig. 1;
> Fig. 3 is a section taken along line III - III of Fig. 1;
> Fig. 4 is a section of an inner ring shown in Fig. 1;
> Fig. 5 is a perspective view of a cylindrical member of a metal for forming a bushing shown in Fig. 1;
> Fig. 6 is an explanatory section showing the state in which the inner ring is covered with the metallic cylindrical member and is set in a pair of press dies;
> Fig. 7 is a section showing the state in which the paired press dies are fastened to cover the inner ring with the bushing;
> Fig. 8 is a section showing the state in which the inner ring has its convex-spherical surface covered with the bushing;
> Fig. 9 is a section showing the state in which the inner ring covered with the bushing is set as a core in molds;
> Fig. 10 is an enlarged section showing an essential portion of Fig. 9;
> Fig. 11 is a section showing a spherical joint according to Embodiment 2 of the present invention;
> Fig. 12 is an enlarged section showing an essential portion of Fig. 11;
> Fig. 13 is a section showing a spherical joint according to Embodiment 3 of the present invention;
> Fig. 14 is an enlarged section showing an essential portion of Fig. 13;
> Fig. 15 is an explanatory diagram showing a thrust f to act upon the ball portion and its reactions f';
> Fig. 16 is an enlarged section showing another example of the elastic cap;
> Fig. 17 is a section showing a spherical joint according to Embodiment 4 of the present invention;
> Fig. 18 is a section showing one example of the spherical joint of the prior art;
> Fig. 19 is a lefthand side elevation of the spherical joint shown in Fig. 18; and
> Fig. 20 is a perspective view showing an example of the link mechanism which is constructed by using the spherical joint shown in Fig. 18.

Preferred embodiments of the present invention will be specifically described in the following with reference to the accompanying drawings.

Embodiment 1

In Figs. 1 to 3, there is shown a spherical joint according to Embodiment 1 of the present invention. This spherical Joint is constructed to include an inner ring (or inner member) 1 having a convex-spherical surface 5 on its outer surface, a holder 2 (or outer member) formed at its one end with an inner ring retaining portion 6 for holding the inner ring 1 in a rotating or rocking manner and at its other end with a connecting portion 7 for connection with an external device, and a thin bushing 3 made of free-cutting brass and sandwiched between the inner ring 1 and the holder 2. The inner ring 1 is formed by boring a spherical member of high-carbon bearing steel with a through hole 4 for fixing a shaft, and the holder 2 is die-cast of an aluminum alloy (of Japanese Industrial Standards No. ADC12).

On the other hand, the bushing 3 is fused, when the holder 2 is die-cast, to the inner face of the inner ring retaining portion 6 of the holder 2. This bushing 3 is formed with a concave-spherical surface 8, which is made slidable relative to the convex-spherical surface 5 of the inner ring 1, and an annular groove 9 which extends circumferentially in the Inner surface of the central portion of the bushing 3 for providing a reservoir for lubricating oil.

The spherical joint of this Embodiment 1 is manufactured, as follows.

First of all, the inner ring 1 is prepared by boring a spherical material of high-carbon bearing steel with the shaft fixing through hole 4, as shown in Fig. 4. This inner ring 1 is hardened and then ground, and its convex-spherical surface 5 is lapped.

Next, as shown in Fig. 5, a cylindrical member 10 is formed of free-cutting brass having a melting point of 885 °C to have an internal diameter substantially equal to the external diameter of the inner ring 1 and a thickness (t) of 0.5 mm. This cylindrical member 10 is pressed to the aforementioned bushing 3.

Next, as shown in Fig. 6, the cylindrical member 10 is fixed on the inner ring 1 coaxially with each other, and these two are set and pressed between a pair of press dies 11a and 11b.

Here, these paired press dies 11a and 11b are formed at their individual leading ends with die portions 12 so that the aforementioned cylindrical member 10 is caulked into close contact with the convex-spherical surface of the inner ring 1 when the press dies 11a and 11b are fastened. Moreover, the press die 11a is arranged at its central portion with a male piston 14a biased by a spring, whereas the other press die 11b is also arranged at its central portion with a spring-biased female piston 14b. The male piston 14a has its center pin 15a extended through the through hole 4 of the inner ring 1, as set in the press die, so that it is fitted in the female piston 14b. This positions the inner ring 1 and the cylindrical member 10 in the press dies.

Moreover, the die portions 12 are formed with notched grooves 13 corresponding to the annular groove 9 of the aforementioned bushing 3. On the other hand, the male piston 14a and the female piston 14b are formed at their individual portions with thrust projections 16a and 16b for thrusting against the two end portions of the cylindrical member 10 when the press dies 11a and 11b are fastened.

As shown in Fig. 7, moreover, the inner ring 1 and the cylindrical member 10 are set between the paired press dies 11a and 11b. As these press dies 11a and 11b are fastened, the cylindrical member 10 is caulked at its two end portions by the die portions 12 so that it comes into close contact with the convex-cylindrical surface 5 of the inner ring 1. Simultaneously with this, the cylindrical member 10 is thrust from the two ends to the center by the thrust projections 16a and 16b of the male piston 14a and the female piston 14b so that a portion comes into the notched grooves 13 formed in the die portions 12. As a result, the cylindrical member 10 is shaped into the bushing 3 covering the convex-spherical surface 5 of the inner ring 1, and this bushing 3 is formed in its inner circumference with the annular groove 9 which extends in the circumferential direction of the bushing 3.

After the convex-spherical surface 5 of the inner ring 1 has thus been covered with the bushing 3, these inner ring 1 and bushing 3 are placed as a cover in die-casting molds 18a, 18b and 18c, as shown in Fig. 9. A molten metal of an aluminum alloy (of Japanese Industrial Standards No. ADC12) having a melting point of 580 °C is inJected into the cavity 19 which is defined by those die-casting molds 18a, 18b and 18c, to cast the holder 2, as shown in Fig. 2, around the aforementioned bushing 3.

At this time, the bushing 3 has its outer circumference melted by the heat of the molten metal so that it is fused to the cast holder 2. As a result, the bushing 3 is rigidly unified with the cast holder 2, so that no displacement is established between the holder 2 and the bushing 3 even if the inner ring 1 later rocks or rotates relative to the holder 2.

Fig. 10 is an enlarged section showing the contacting states between the bushing 3 and the die-casting molds 18a and 18b. In this die-casing process, as shown in Fig. 10, the bushing 3 is given the thickness of t = 0.5 mm so that the its end portions never fail to abut against the gate cutting portions 20 of the die-casting molds 18a and 18b. This prevents the molten metal inJected into the cavity 19 from flowing over the bushing 3 and from being fused to the inner ring 1.

Moreover, the holder 2 thus die-cast is integrated with the inner ring 1 through the bushing 3. When the holder 2 is removed to cool from the die-casting molds 18a, 18b and 18c, it shrinks to fasten the bushing 3. As a result, the bushing 3 comes into closer contact with the convex-spherical surface of the inner ring 1 so that the concave-spherical surface 8 formed on the bushing 3 takes the contour which is transferred from the convex-spherical surface 5 of the inner ring 1. Thus, the con-

cave-spherical surface 8 is a reflection of the sphericalness of the convex-spherical surface 5 of the inner ring 1.

After the holder 2 has been sufficiently cooled down, an external force is applied to the inner ring 1 or the holder 2 to establish a small clearance between the convex-spherical surface 5 of the inner ring 1 and the concave -spherical surface 8 of the bushing 3. This clearance ensures a smooth sliding contact between the inner ring 1 and the bushing 3 to provide a spherical Joint in which the inner ring 1 can rotate or rock relative to the holder 2.

Embodiment 2

Figs. 11 and 12 show a spherical Joint according to Embodiment 2 of the present invention. This spherical joint is constructed, unlike the foregoing Embodiment 1, to include a ball rod (or inner member) 21 formed at its one end with a ball portion 22 and at its other end with a connecting portion 23, a holder (or outer member) 24 formed at its one end with a ball retaining portion 25 to be jointed to the ball portion 22 and at its other end with a connecting portion 26, and a bushing 27 sandwiched between the ball portion 22 of the ball rod 21 and the ball retaining portion 25 of the holder 24. In this embodiment, the holder 24 and the bushing 27 are made of the same materials as those of the foregoing Embodiment 1.

In this spherical joint, moreover, a seal member 28 is sandwiched between the edge of the ball retaining portion 25 of the holder 24 and the connecting portion 23 of the ball rod 21. An opening, as formed in the bottom of the ball retaining portion 25 of the holder 24, is covered with a cover member 30. Lubricating oil pockets 29 and 31 are formed above and below the ball portion 22.

The process for manufacturing this spherical joint is absolutely identical to the aforementioned one of Embodiment 1. Specifically, the bushing 27 is pressed to cover the ball portion 22 of the ball rod 21. Then, the aforementioned holder 24 is die-cast by using the ball portion 22 as the core. After the holder 24 thus cast has been cooled down, the external force is applied to the holder 24 or the ball rod 21 to allow the ball rod 21 to freely rock or rotate relative to the holder 24.

According to this Embodiment 2, too, the bushing 27 is fused, as in the case of Embodiment 1, to the ball retaining portion 25 of the holder 24 at the time of die-casting the holder 24. As a result, the holder 24 and the bushing 27 are rigidly unified so that the bushing 27 is not displaced from the holder even by the rotating or rocking motions of the ball rod 21. Moreover, the sphericalness of the ball portion 22 of the ball rod 21 is reflected without fail upon the concave-spherical surface of the bushing 27 so that the bushing 27 and the ball portion 22 come into smooth sliding contact to allow the ball rod 21 to move relative to the holder 24.

Embodiment 3

Fig. 13 shows a spherical joint according to Embodiment 3 of the present invention. In Fig. 13, reference numeral 41 designates a holder which is formed with a ball retaining portion 42 at its one end and a connecting portion 43 at its other end. This connecting portion 43 is internally threaded at 43a, and the ball retaining portion 42 is formed in its top with a connecting mouth 54 and in its bottom with a cap mounting mouth 49 which is opened in a direction perpendicular to the opening direction of the internal thread 43a. On the other hand, numeral 44 designates a ball rod which is formed at its one end with a ball portion 45 having a high sphericalness and at its other end with a connecting portion 46. The ball portion 45 is retained in the ball retaining portion 42 with such minimum necessary clearance as to rotate and rock. The connecting portion 46 is protruded from the ball retaining portion 42 through the aforementioned connecting mouth 54, and this protruded portion is externally threaded at 46a. Moreover, the holder 41 and the ball rod 44 thus constructed are connected generally in the shape of letter "L" to each other.

The ball rod 44 is formed at its root portion with a hexagonal tool engaging portion 51 which can engage with a spanner for turning the ball rod 44 when the connecting portion 46 is fastened at its externally threaded portion 46a to another moving portion (although not shown). Likewise, the holder 41 is formed at one end of its connecting portion 43 with a generally square tool engaging portion 52 which can engage with a spanner.

Between the outer circumferential edge of the ball retaining portion 42 and the root portion of the tool engaging portion 51 of the ball rod 44, on the other hand, there is mounted a seal member 47 partly for forming a lubricant pocket 53 to reserve a lubricant such as grease to be supplied to the clearance between the ball portion 45 and its retaining portion 42 and partly for preventing dust or the like from intruding into that gap from the connecting mouth 54. Here, the end portion 47a of the seal member 47, as located at the side of the ball rod 44, is held in close contact with the ball rod 44 by its elasticity, whereas the end portion 47b at the side of the ball retaining portion 42 is retained on the outer circumferential edge of the ball retaining portion 42 by a retaining ring so that it may not be brought out of the ball retaining portion 42 by the rocking or rotating motions of the ball rod 44.

On the cap mounting mouth 49 of the ball retaining portion 42, as shown in Fig. 14, there is mounted an elastic cap (or elastic member) 48 which is made of soft type synthetic resin or rubber for thrusting against the ball portion 45 of the ball rod 44. The thrust surface of the elastic cap 48 for thrusting against the ball portion 45 is formed therein with a recess 48a which functions as a lubricating oil pocket when the elastic cap 48 is fitted in the cap mounting mouth 49. Moreover, this elastic cap 48 is fixed in the ball retaining portion 42 by caulking the ridge 50

which is formed on the circumferential edge of the cap mounting mouth 49. In the present embodiment, the elastic cap 48 is made of soft nylon, for example.

In the spherical joint thus constructed according to the present embodiment, the elastic cap 48 is held in abutment against the ball portion 45 by such a thrust as to establish a slight elastic deformation in the soft type synthetic resin. This thrust is directed to eliminate the clearance between the ball portion 45 and the ball retaining portion 42 so that the ball portion 45 may be clamped between the elastic cap 48 and the ball retaining portion 42. Specifically the thrust of the elastic cap 48 acts in the direction toward the connecting mouth 54 of the ball retaining portion 42 so that reactions f' against the thrust f of the elastic cap 48 act upon the ball portion 45 along the edge portion of the connecting mouth 54.

As a result, the ball portion 45 is clamped between the elastic cap 48 and the edge of the connecting mouth 54 so that the rotation of the ball portion 45 relative to the ball retaining portion 42 can be prevented without fail by the clamping frictional force. Thus, the backlash between the ball rod 44 and the holder 41 can be eliminated, even in case vibrations are applied to the spherical joint while no load is being transmitted (i.e., in an unloaded state) between the ball rod 44 and the holder 41.

Thanks to the construction in which the ball portion 45 is retained between the elastic cap 48 and the ball retaining portion 42, moreover, the ball rod 44 is prevented from rocking relative to the holder 41. As a result, even in case an impact load or an abrupt acceleration is applied to the spherical joint in the unloaded state, the holder 41 can be prevented from falling around the ball portion 45 relative to the ball rod 44 so that the ball retaining portion 42 can keep its edge from impinging upon the ball rod 44.

On the other hand, even in case the ball portion 45 of the ball rod 44 is retained in the ball retaining portion 42 of the holder 41 by the thrust of the elastic cap 48, the elastic cap 48 is thrust and deformed by the ball portion 45 if a load acts upon the holder 41 or the ball rod 44. As a result, the spherical surface of the ball portion 45 comes into contact with the peripheral surface of the ball retaining portion 42 so that the aforementioned load can be borne without fail. Thus, under the loaded condition, the smooth rocking and rotating motions can be ensured between the holder 41 and the ball rod 44.

Fig. 16 shows another example of the aforementioned elastic cap.

This elastic cap, as designated at 60, is prepared by adhering a soft type synthetic resin or rubber 62 to one side of a metallic plate 61. Like the elastic cap 48 of the foregoing Embodiment 3, the elastic cap 60 is fixed on the ball retaining portion 42 by inserting the plate 61 in the cap mounting mouth 49 of the ball retaining portion 42 and then by caulking the ridge 50 which is formed on the circumferential edge of the cap mounting mouth 49.

In the case of using this elastic cap 60, too, the backlash between the ball rod 44 and the holder 41 under the unloaded condition can be prevented. In this elastic cap 60, moreover, the ball portion 45 can be thrust by the elasticity of the metallic plate 61 fixed in the cap mounting mouth 49. This raises an advantage that the backlash between the ball rod 44 and the holder 41 can be more reliably prevented than the elastic cap 48 made of a soft type synthetic resin.

Embodiment 4

Fig. 17 shows a spherical joint according to Embodiment 4 of the present invention.

In Fig. 17, reference numeral 70 designates a holder which is formed with a ball retaining portion 71 at its one end and a connecting portion 72 at its other end. This connecting portion 72 has its outer circumference externally threaded (although not shown), and the ball retaining portion 71 has its leading end portion opened to form a connecting mouth 73. On the other hand, the connecting portion 72 is formed therethrough with a stick inserting hole 74 which has its one end opened into the aforementioned ball retaining portion 71.

On the other hand, numeral 75 designates a ball rod which is formed at its one end with a ball portion 76 having a high sphericalness and at its other end with a connecting portion 77. The ball portion 76 is retained in the ball retaining portion 71 with such minimum necessary clearance as to rotate and rock. The connecting portion 77 is protruded from the ball retaining portion 71 through the aforementioned connecting mouth 73, and this protrusion is externally threaded at 77a. Moreover, the holder 70 and the ball rod 75 thus constructed are connected generally in a straight line.

As in the foregoing Embodiment 1, moreover, the ball rod 75 is formed at its root portion with a hexagonal tool engaging portion 78. Between the outer circumferential edge of the ball retaining portion 71 and the root portion of the tool engaging portion 78 of the ball rod 75, on the other hand, there is mounted a seal member 79 for forming a lubricant pocket 80.

Into the stick inserting hole 74 of the holder 70, moreover, there is press-fitted an elastic stick (or elastic member) 81 for thrusting against the ball portion 76 of the ball rod 75. This elastic stick 81 is fixed in the stick inserting hole 74 by forcing it into the stick inserting hole 74 and then by caulking the circumferential edge of the stick inserting hole 74 at the end face of the connecting portion 72. Before the elastic stick 81 is press-fitted, the stick inserting hole 74 may be filled up with the lubricating oil to lubricate the fine clearance between the ball retaining portion 71 and the ball portion 76.

In the spherical joint thus constructed according to the present embodiment, too, the ball portion 76 is retained at in the foregoing Embodiment 3 between the elastic stick 81 and the edge portion of the connecting mouth 73. As a result, under the so-called "unloaded condition" having no load transmission between the ball rod 75 and the holder 70, the backlash between the ball

rod 75 and the holder 70 can be prevented, and the holder 70 can be prevented from falling relative to the ball rod 75. Under the loaded condition, on the other hand, the elastic stick 81 is thrust and deformed by the ball portion 76. As a result, the spherical surface of the ball portion 76 comes into contact with the spherical surface of the ball retaining portion 71 so that smooth rocking and rotating motions can be retained between the holder 70 and the ball rod 75.

Incidentally, in the present embodiment, the elastic stick 81 is press-fitted in the stick inserting hole 74 which is formed in the holder 70. Alternatively, this hole 74 may be filled up with a molten synthetic resin injected into the hole 74.

Thus, in at least preferred embodiments there is provided both a spherical joint, which can achieve smooth rotating and rocking motions of the inner member relative to the outer member and which is excellent in durability, and a process for manufacturing the spherical joint; and there is provided a spherical joint which can prevent any backlash between the inner member and the outer member under the condition of no load and can transmit the load accurately between the inner member and the outer member even after the aging of use and which can be freed from any deterioration of the smoothness of the rocking and rotating motions. In at least preferred embodiments of the invention viewed from the first aspect, the thin metal bushing may be formed from a thin metal member or sheet of metal, at least preferably having a melting point higher than the melting point of the outer member, and at least preferably is formed from a thin sheet of metal by a pressing technique.

Claims

1. A spherical joint comprising: an inner member (1; 21) having a convex-spherical surface (5); an outer member (2; 24) cast by using said inner member (1, 21) as a core and so connected to said inner member (1; 21) as to be capable of rocking and rotating relative to said inner member (1; 21); and a bushing (3; 27) sandwiched between said inner member (1; 21) and said outer member (2; 24) and having a concave-spherical surface (8) for sliding contact with the convex-spherical surface (5) of said inner member (1; 21),

   characterised in that said bushing (3; 27) is made of a thin metal and is fused to said outer member (2; 24) when said outer member (2; 24) is cast.

2. A spherical joint according to claim 1, wherein said bushing (3; 27) is formed with an annular groove (9) extending in the circumferential direction of the concave-spherical surface (8) thereof for providing a lubricating oil reservoir.

3. A spherical joint according to claim 1 or 2, wherein the metal for casting said outer member (2; 24) is an aluminum metal having a melting point of 570 to 750 °C, and wherein the metal for making said bushing (3; 27) is a copper metal having a melting point of 800 to 900 °C.

4. A spherical joint according to claim 1 or 2, wherein the metal for casting said outer member (2; 24) is a zinc metal having a melting point of 420 to 450 °C and wherein the metal for making said bushing (3; 27) is a copper metal having a melting point of 800 to 900 °C.

5. A spherical joint according to claim 1 or 2, wherein the metal for casting said outer member (2; 24) and the metal for forming said bushing (3; 27) have a melting point difference of 100 to 400 °C.

6. A process for manufacturing a spherical joint, which spherical joint includes: an inner member (1; 21) having a convex-spherical surface (5); an outer member (2; 24) cast by using said inner member (1; 21) as a core and so connected to said inner member (1; 21) as to be capable of rocking and rotating relative to said inner member (1; 21); and a bushing (3; 27) sandwiched between said inner member (1; 21) and said outer member (2; 24) and having a concave-spherical surface (8) for sliding contact with the convex-spherical surface (5) of said inner member (1; 21), the process comprising:

   the step of covering said inner member (1; 21) with said bushing (3; 27), which bushing (3; 27) is made of a thin metal;
   the step of placing said inner member (1; 21) covered with said bushing (3; 27) in a casting mold and pouring a molten metal into said casting mold to cast said outer member (2; 24) and to fuse said bushing (3; 27) to said outer member (2; 24);
   the step of extracting the outer member (2; 24) connected to said inner member (1; 21), from said casting mold and cooling down said outer member (2; 24), and fastening said bushing (3; 27) onto the convex-spherical surface (5) of said inner member (1; 21) by using the shrinkage of said outer member (2; 24), to bring the convex-spherical surface (5) of said inner member (1; 21) and the concave-spherical surface (8) of said bushing (3; 27) into close contact with each other; and
   the step of applying an external force to said inner member (1; 21) or said outer member (2; 24) to establish a fine clearance between the convex-spherical surface (5) of said inner member (1; 21) and the concave-spherical surface (8) of said bushing (3; 27).

7. A spherical joint manufacturing process according to claim 6, wherein said inner member (1; 21) is covered with said bushing (3, 27) by placing said inner member (1; 21) in the hollow portion of a metal sleeve (10), and caulking the two end portions of said sleeve (10) to form said bushing (3; 27), and said bushing (3; 27) is formed with an annular groove (9) extending in the circumferential direction of the concave-spherical surface (8) of said bushing (3; 27) for providing a lubricating oil reservoir.

8. A spherical joint comprising: an inner member (44; 75) having a convex-spherical surface; and an outer member (41; 70) cast by using said inner member (44; 75) as a core and so connected to said inner member (44; 75) as to be capable of rocking and rotating relative to said inner member (44; 75),
characterised by: a mouth (49; 74) formed in the ball retaining portion (42; 71) of said outer member (41; 70) and communicating with the convex-spherical surface of said inner member (44; 75); and an elastic member (48; 60; 81) fitted in said mouth (49; 74) for thrusting against said convex-spherical surface, when a load is not transmitted between said inner member (44; 75) and said outer member (41; 70), and for being thrust and deformed by said convex-spherical surface when a load is transmitted between said inner member (44; 75) and said outer member (41; 70).

9. A spherical joint according to claim 8, wherein said inner member (44) is formed as a ball rod having a ball portion (45) at one end and a threaded portion (46) at its other end, wherein said outer member (41) is formed as a holder having a ball retaining portion (42) for retaining said ball portion (45) at one end and a threaded portion (43) at its other end, wherein said inner member (44) and said outer member (41) are connected generally in the shape of a letter "L", and wherein said elastic member (48; 60) is formed as a cap covering said mouth (49).

10. A spherical joint according to claim 8, wherein said inner member (75) is formed as a ball rod having a ball portion (76) at one end and a threaded portion (77) at its other end, wherein said outer member (70) is formed as a holder having a ball retaining portion (71) for retaining said ball portion (76) at one end and a threaded portion (72) at its other end, wherein said inner member (75) and said outer member (70) are connected generally in a straight line, wherein said mouth (74) is formed through the ball retaining portion (71) of said outer member (70) and said threaded portion (72), and wherein said elastic member (81) is formed into an elongate shape to be fitted in said mouth (74).

FIG. 1

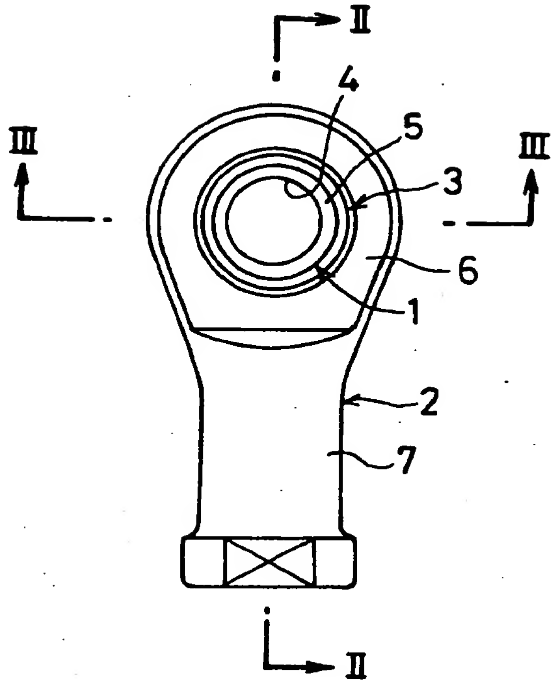


FIG. 2

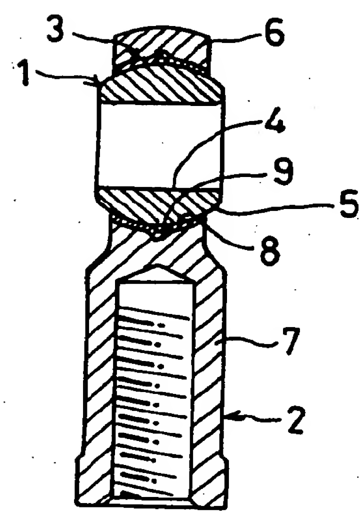


FIG. 3

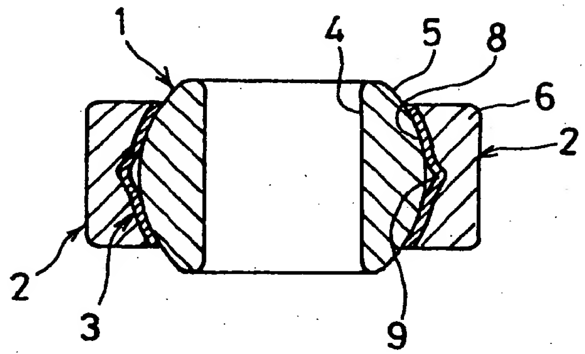


FIG. 4

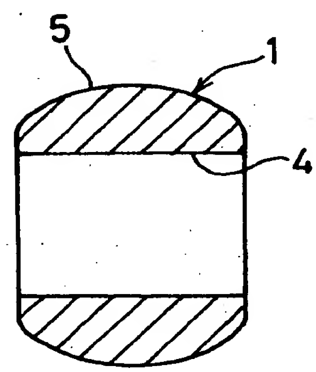


FIG. 5

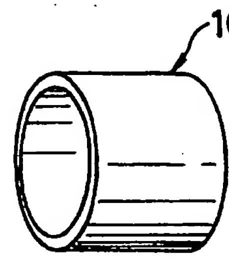


FIG. 6

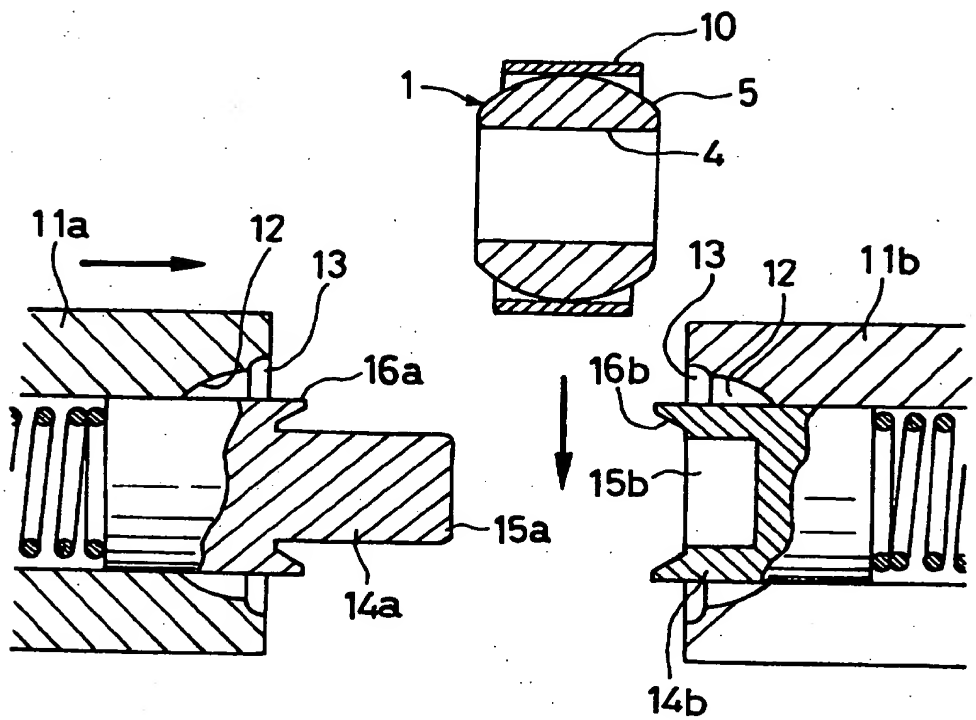


FIG. 7

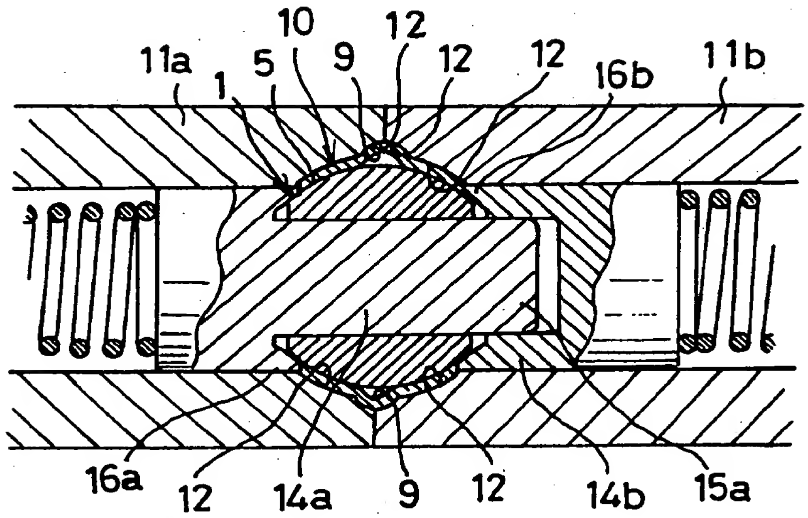


FIG. 8

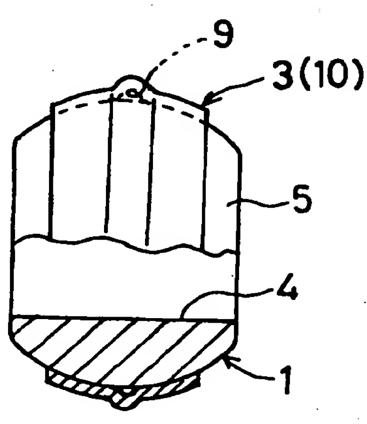


FIG. 9

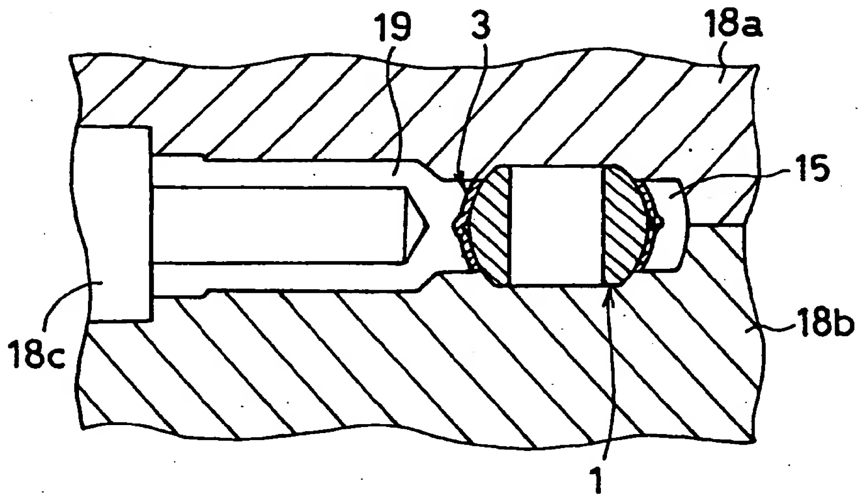


FIG.10

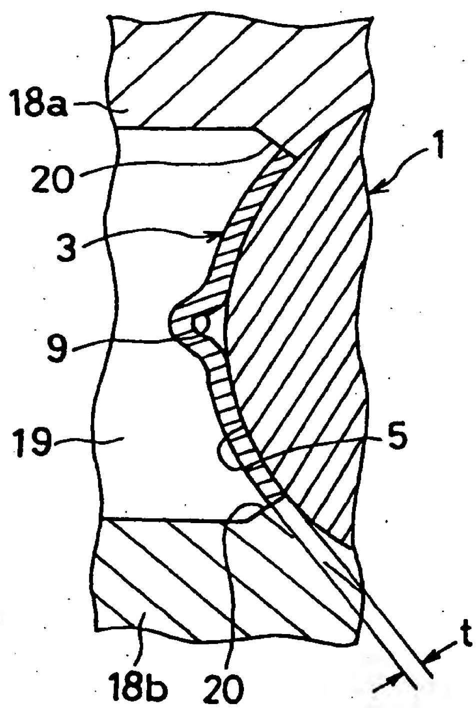


FIG.11

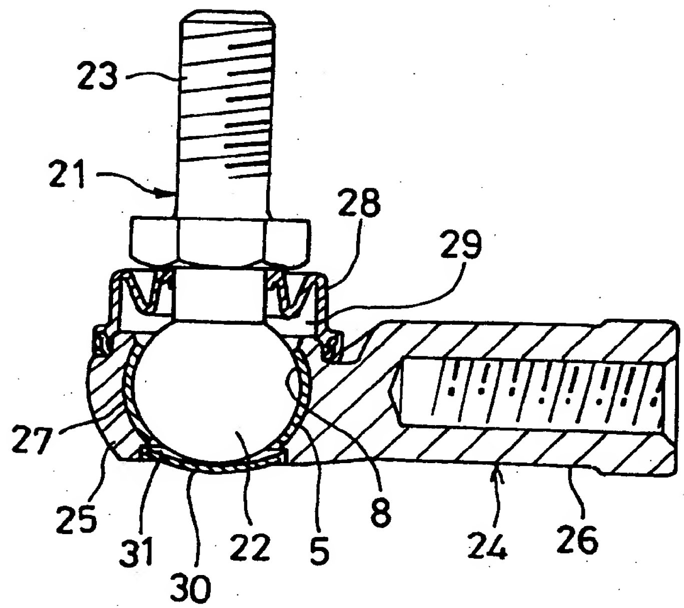


FIG.12

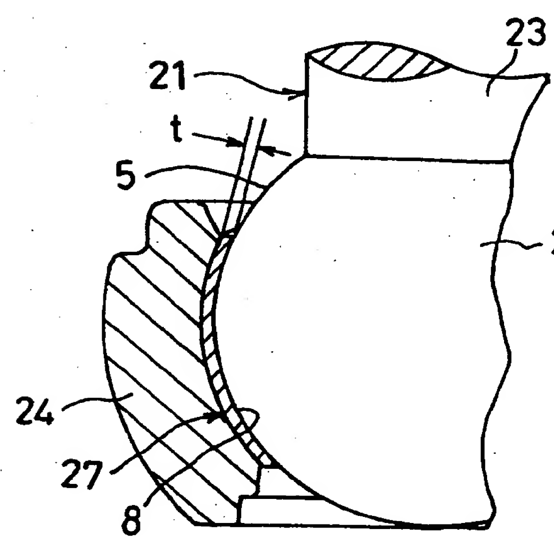


FIG.13

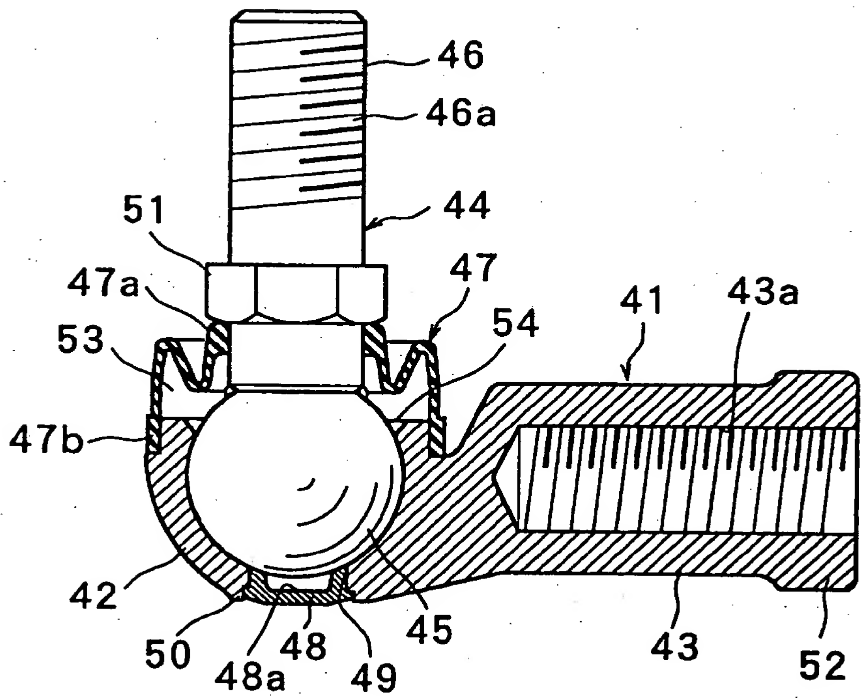


FIG.14

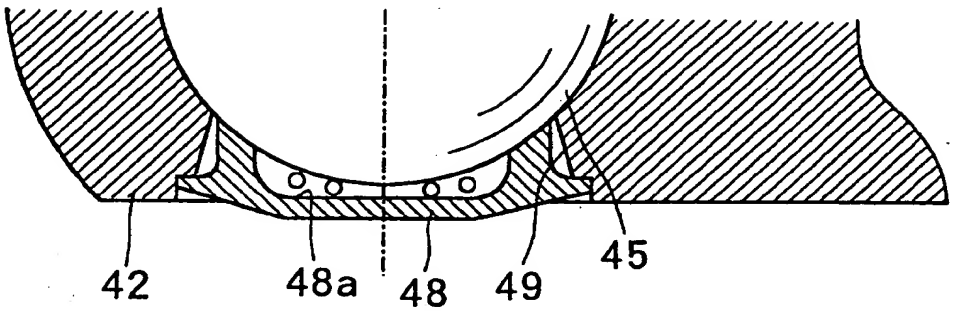


FIG.15

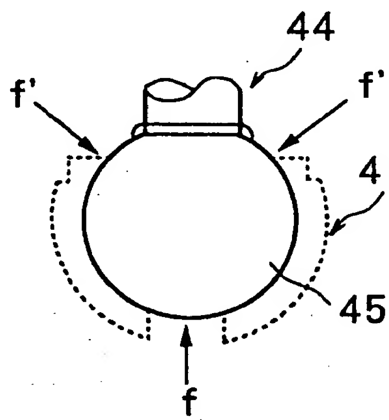


FIG.16

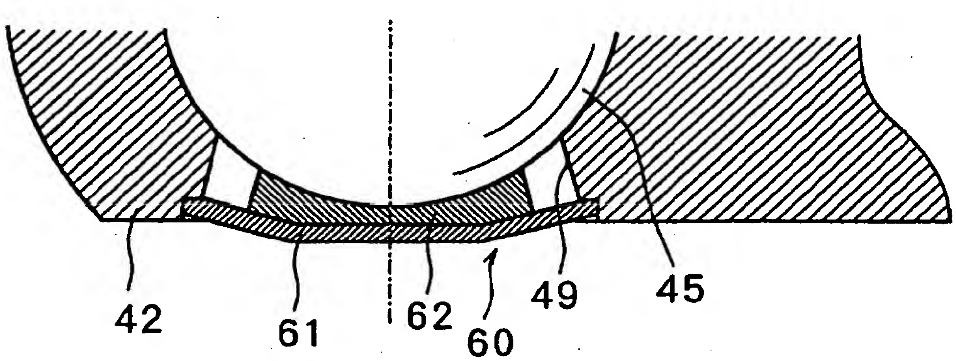


FIG.17

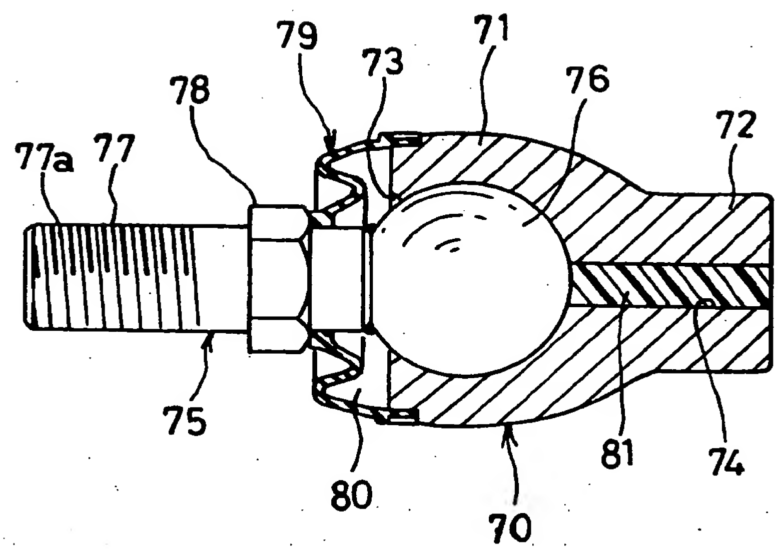


FIG.18
Prior Art

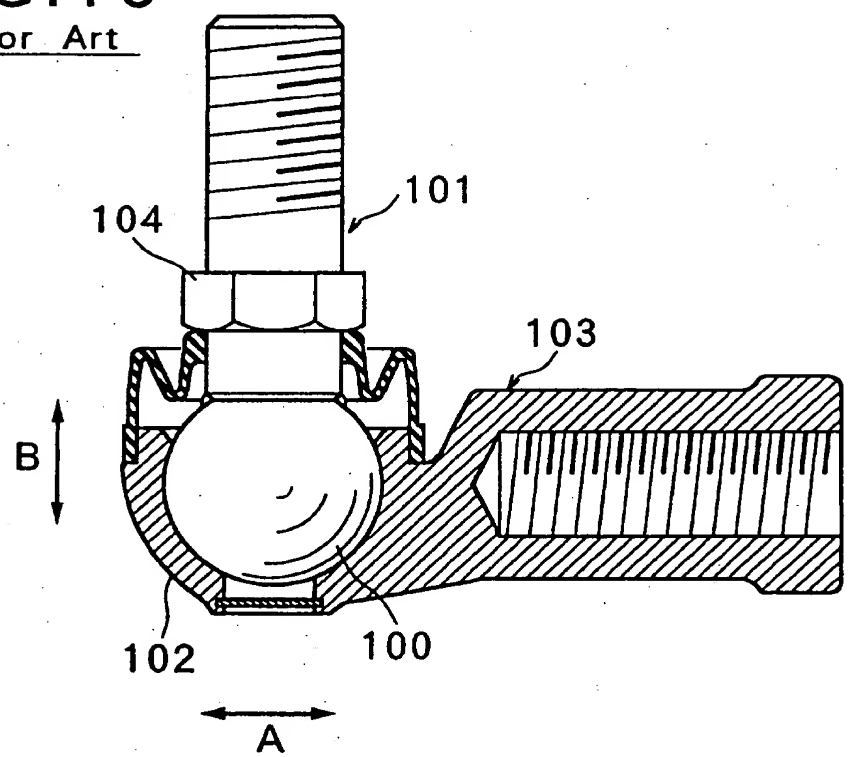
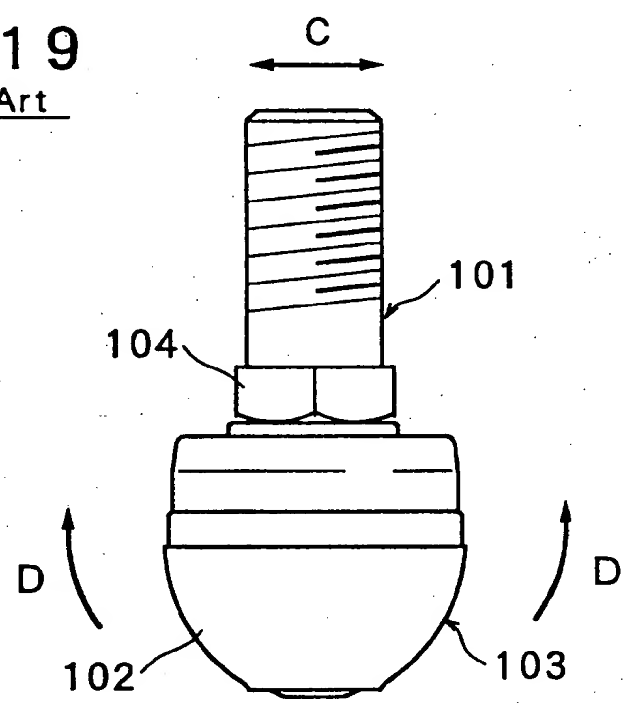


FIG.19
Prior Art



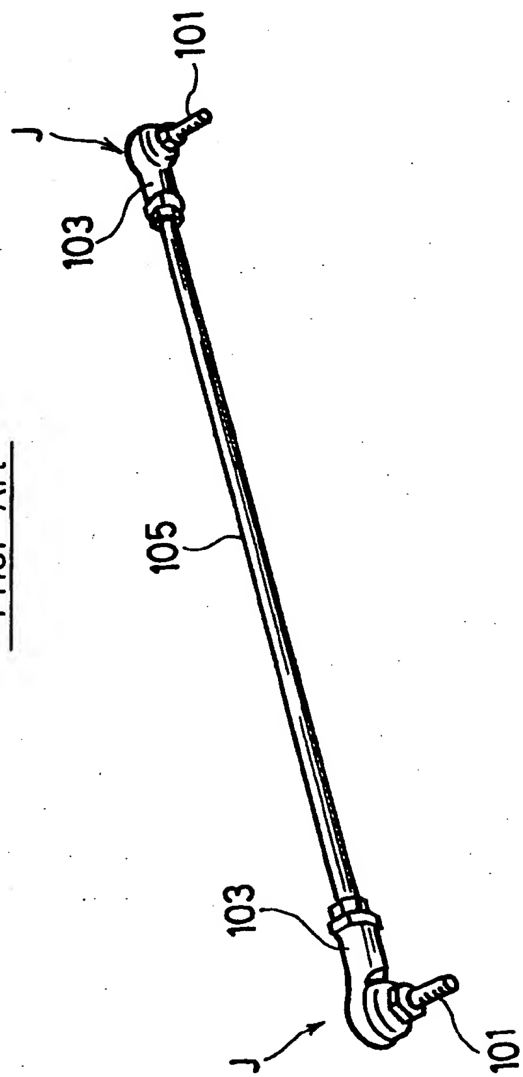


FIG.20
Prior Art